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ABSTRACT

Sixty undergraduates were given one of five programmed mathematics texts. The texts were either completely programmed, programmed only for definitions, programmed only for calculations, programmed only for conceptual information, or not programmed at all. Time spent reading each section of the eight-unit text was recorded and a 24-question posttest was administered. The results showed that although programming increased the time spent reading the programmed sections, it did not enhance posttest performance on the material in those sections. An explanation of programmed instruction based on a simple time-spent model is discussed. (Author/MK)

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An Analysis of Time Spent Reading in Programmed Instruction

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An Analysis of Time Spent Reading

in Programmed Instruction

Since its inception, the most researched feature of Programmed Instruction (PI) has been its requirement of a constructed response. Most reviewers agree that this requirement is crucial when the student must learn an unfamiliar, often technical te m (Tobias, 1973; Hartley, 1974). One explanation for this finding is that forcing the student to fill in blanks increases the amount of time s/he spends working on the new response. In support of this notion is the fact that those who use PI spend as much as twice the amount of time reading as those using other instructional modes (Anderson, 1967; Hartley, 1974; Holland, 1965). The present study examines the relationship between this time variable and achievement on certain types of programmed material.

Evidence from a related area of instructional psychology indicates that asking questions about different types of content before or after a student reads a passage can lead to different types of learning outcomes (Wittrock, 1977). Mayer (1975) found that asking questions about definitions led to a increased performance on definitions. Similarly, asking calculational questions selectively facilitated the learning of calculational material. Asking broader, more conceptual questions did not have these same selective effects. Instead, these subjects showed gains in all three areas. Evidence for similar effects in PI was reported by Anderson (1967). He attributes much of PI's facilitative effect to attentional variables. The presence of the empty spaces is seen as forcing the students to orient to to a particular portion of the text. This is much the same argument used to explain the effects of inserted questions. The present study extends Mayer's finding to PI by programming selected types of content. For some subjects, definitions

are programmed; for others calculations and conceptual models are programmed.

Method

Subjects

Sixty male and female UCSB undergraduates served. None had recent experience with probability theory.

Design

Each subject in one of the five conditions that corresponded to the type of text received. The texts were either entirely programmed, programmed for formal definitions only, programmed for calculations only, programmed for conceptual models only, or not programmed at all. The post test contained questions concerning definitions, calculations and models. Hence, performance by question type comparisons are of the within subject variety.

Materials

Mayer's (1975) text on probability theory was used. This text is divided into the following eight units: addition of probabilities of mutually exclusive events, addition of probabilities of non-mutually exclusive events, joint probability of independent events, joint probability of dependent events, generation of the total number of joint outcomes, generation of the total number of ordered samples, permutations, and combinations. Each passage is divided into three parts. The definition states the formula in symbols and words. The calculation part demonstrates the use of the formula with numbers. The model represents the formula in terms of a conceptual diagram. In the present study each of these components was presented on 5-inch by 8-inch index cards. The definitions and calculations could be represented on one such card each; the model information required at least two cards. The entire text was 32 cards long.

Five sets of the text were created. In the first, the key words were underlined (U). In the second, these same words were removed, leaving blanks in their place (A). In the third, fourth and fifth sets, the key words from certain parts of the text were replaced with blanks. The definition text (D) contained blanks only in those portions of the text that presented the probability formulas. The calculation text (C) and model texts (M) contained blanks in the calculation and model portions of the text respectively.

The post-test was composed of three questions from each of the eight lessons for a total of 24. The three questions corresponded to the three parts of the unit. This test was also presented on the 5-inch by 8-inch index cards.

Procedure

The subjects were run for two hours in groups of two or three. Upon entering the laboratory they were seated at one of the three enclosed booths. They were instructed to work through the set of index cards that had been placed before them. Those receiving the A, D, C, and M texts were also instructed to fill in the blanks as they came to them. All subjects were asked to pass each card they read through a 3-inch by 11-inch window when they they were finished with it. Reading time was measured by the experimenter who was seated in front of this window with a stop watch. Finally, the subjects were informed that they would be taking a post-test on the material.

The texts were randomly assigned to the subjects. Each text was read by 12 subjects. At the completion of the text, the post questions were given.

Results and Discussion

Table 1 shows the average seconds spent reading each frame as a function of the frame type for all five groups. Both main effects are significant

(F=15.65, p .01, df=4,55 for conditions; F=25.3, p .01, df=2,110 for frame type). The type x condition interaction is also significant (F=68.0, p .01, df=8,110). The requirement of a constructed response clearly led to significant increases in reading time. These increases were selective in nature. The sections of the D, C, and M texts that were not programmed were no different in reading times from those same sections in the underlined texts. The blanks forced more study of the programmed material, but had little effect on the nonprogrammed material.

The average total reading times (in minutes) were 70 for the A text, 42 for the D text, 39 for the C text, 58 for the M text, and 28 for the U text. The all programmed text required more than twice as much time to complete as the underlined text.

Table 2 shows the proportion of correct responses on the post-test questions for all five groups. Although there is a significant difference for question types (F=10.25, p .01, df=2,110), neither the main effect for conditions (F=.79, ns, df=4,55), nor the interaction (F=.65, ns, df=8.110) is significant. Thus, although PI did increase study time, it did not lead to an increase in performance. This is most clearly indicated by comparing the groups that read the A and U texts. Although the former spent twice as much time reading, the two groups post-test scores were virtually identical. In addition, these data do not replicate the findings of Mayer (1975) that forcing subjects to attend to broader conceptual material will produce general performance gains.

The theory that the time a student spends in instruction is a major determinant of learning has been raised by a number of researchers (Tobias, 1973). The theory implies that what a student does with the instructional material is unimportant - as long as s/he is somehow interacting with it.

The present study suggests that this is not the case. It seems that a small amount of some types of study can be just as effective (or ineffective) as a great deal of other types of study. Practically speaking, this study suggests caution in choosing this particular instructional technique. PI will almost certainly take more time and may not facilitate learning.

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